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BY

HENRY E. WRIGLEY,

CIVIL ENGINEER.

CLEVELAND, O.:

W. S. ROBISON & CO., 65 AND 67 FRANKFORT ST.

1872

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Table of Air-Line Distances

BETWEEN THE PRINCIPAL POINTS IN THE

PENNSYLVANIA OIL REGION,

COMPILED FROM THE LARGE MAP OF

HENRY E. WRIGLEY. C. E.

	Corry	Cochranton	Clarion	Callensburg	Cash Up	Edinboro'	Emlenton	Enterprize	Franklin	Fagundas	Foster	Garland	Gas City	Harrisville	Irvinetown	Lacytown	Meadville	Martinsburg	McClintockville	Miller Farm	New Bethlehem	Oil City	Oleopolis	Pleasantville	Pithole	Parker's Landing	Petroleum Centre	Plumer	Pioneer	Pittsfield	President	Rouseville	Scrub Grass	Shippenville	Sunbury	Shamburg	St. Petersburg	Spartansburg	Townville	Titusville	Tidioute	Tionesta	Trunkeyville	Triumph	Utica	Union	Venango City	Waterloo	West Spring Creek	Youngsville
Corry	0																																																
Cochranton	34.8	0																																														
Clarion	49.8	40.1	0																																													
Callensburg	54.1	37.0	10.7	0																																												
Cash Up	27.6	26.8	22.4	27.1	0																																										
Edinboro'	26.0	24.4	58.9	58.9	38.8	0																																									
Emlenton	50.5	29.0	17.0	9.0	25.0	57.8	0																																									
Enterprize	20.8	25.9	29.1	33.6	6.8	33.8	30.7	0																																								
Franklin	30.9	14.0	26.1	23.5	17.6	35.8	16.0	20.3	0																																							
Fagundas	23.3	32.8	27.5	34.1	8.4	40.1	33.1	7.2	25.6	0																																						
Foster	41.0	19.8	21.3	17.5	30.1	41.6	10.3	22.5	6.0	26.5	0																																					
Garland	12.0	37.9	41.5	47.9	20.9	36.0	45.9	15.4	35.4	14.0	37.9	0																																				
Gas City	40.1	27.1	13.1	14.0	13.4	46.1	12.0	19.5	13.4	21.0	15.3	34.12	0																																		
Harrisville	56.0	24.9	33.5	24.5	36.0	49.2	16.5	39.5	19.5	44.1	17.9	54.8	25.8	0																																
Irvinetown	20.1	46.2	43.0	50.9	25.6	45.2	50.6	21.8	46.1	17.5	43.8	9.2	38.2	61.0	0																																
Lacytown	33.5	35.3	17.5	25.3	9.2	47.5	26.5	14.2	24.2	10.2	22.8	23.8	14.6	40.0	25.6	0																																
Meadville	32.5	9.8	49.0	46.4	32.7	16.0	38.5	30.0	23.3	39.0	29.0	39.0	35.5	33.5	48.0	41.7	0																																
Martinsburg	57.7	34.1	20.5	10.0	32.1	57.7	7.2	37.9	22.5	40.0	17.0	53.0	32.2	16.0	57.3	32.9	43.6	0																																
McClintockville	31.6	19.5	22.6	23.6	9.0	36.3	19.0	12.5	8.7	17.0	10.0	27.8	10.0	27.2	33.9	16.1	27.0	26.1	0																																
Miller Farm	24.7	20.7	27.2	30.0	6.5	32.5	26.0	6.0	14.5	12.2	17.0	20.9	15.7	33.6	27.7	15.6	26.3	33.0	7.1	0																														
New Bethlehem	64.5	51.0	14.5	14.0	36.5	72.0	23.0	43.3	37.2	42.0	31.2	55.8	26.0	37.1	56.7	31.7	60.2	21.5	36.0	41.2	0																													
Oil City	33.4	19.0	22.0	22.2	10.5	37.0	17.2	14.2	7.2	18.5	8.2	29.4	9.0	25.5	35.6	16.9	27.2	24.5	1.8	9.0	35.0	0																													
Oleopolis	32.0	23.5	19.7	22.3	6.1	39.2	19.2	11.3	12.2	14.3	12.0	26.5	8.3	29.7	31.6	12.0	30.7	26.5	4.0	7.7	33.5	5.0	0																												
Pleasantville	23.3	25.1	26.9	31.1	4.5	34.7	28.2	2.4	18.2	7.9	20.2	17.4	17.3	37.5	23.5	12.8	30.0	35.7	10.3	4.9	11.4	12.0	9.2	0																											
Pithole	27.6	24.5	22.7	26.7	2.0	37.2	24.0	6.7	15.5	10.0	16.5	21.7	12.7	34.0	27.3	10.9	30.5	31.1	7.0	5.0	37.3	8.5	4.6	1.5	0																										
Parker's Landing	55.2	33.2	17.4	7.1	29.0	56.3	4.7	34.9	20.6	36.7	15.0	49.9	15.7	17.5	54.1	29.6	42.6	3.5	23.2	30.5	20.0	21.8	33.5	32.6	28.1	0																									
Petroleum Centre	27.7	19.2	25.3	27.1	7.2	33.6	22.9	9.0	11.4	14.5	13.8	24.1	13.2	30.5	30.7	16.0	25.8	30.0	4.0	3.2	39.0	5.5	5.6	7.1	5.2	27.5	0																								
Plumer	29.3	21.0	23.0	24.3	6.0	36.0	21.5	9.2	11.7	14.0	13.0	24.7	11.2	30.3	30.7	14.0	27.9	28.9	3.2	4.6	36.7	5.0	3.3	7.2	4.0	26.0	2.2	0																							
Pioneer	26.7	20.0	25.5	27.7	6.7	33.5	23.5	8.0	12.1	13.5	14.5	23.2	13.7	31.3	29.7	15.5	26.1	30.7	4.7	2.5	39.2	6.5	5.9	6.1	4.7	28.2	1.0	2.5	0																						
Pittsfield	14.7	41.0	42.0	49.1	22.5	39.1	17.5	17.9	38.0	15.0	40.0	3.5	35.7	57.2	5.9	24.5	42.0	54.7	30.1	23.5	52.5	32.0	28.6	20.0	24.0	51.7	26.8	27.2	26.0	0																					
President	32.2	26.3	18.0	22.0	5.2	41.7	20.0	11.5	15.0	12.7	14.0	25.9	8.3	31.7	30.0	9.1	33.6	27.2	7.0	9.2	32.0	7.7	3.0	9.2	4.7	24.0	8.0	5.7	8.0	27.6	0																				
Rouseville	31.0	19.2	23.0	24.0	8.7	36.0	19.2	12.0	9.0	16.7	10.2	27.3	10.2	27.5	33.5	16.0	26.7	26.5	0.5	6.7	3.60	2.2	4.2	10.1	6.7	24.0	3.5	3.0	4.3	29.9	7.1	0																			
Scrub Grass	27.2	20.0	23.5	17.5	23.0	43.3	9.0	27.5	8.7	31.5	5.0	42.5	13.5	12.7	48.6	27.4	29.6	14.2	15.0	21.5	31.8	13.0	17.0	25.2	21.5	13.0	18.5	18.0	19.2	44.9	19.0	15.0	0																	
Shippenville	46.5	35.5	4.5	9.7	19.0	54.5	13.6	25.6	21.5	25.0	16.5	38.7	8.5	30.0	41.2	15.7	44.0	18.5	18.0	23.0	18.0	17.5	15.5	23.5	1.90	15.0	21.0	19.0	21.5	40.0	10.2	18.5	19.5	0																
Sunbury	62.2	34.0	29.5	19.1	38.6	58.3	14.2	43.6	25.5	46.5	21.2	58.9	26.1	10.5	64.2	40.9	43.1	9.2	31.2	38.2	29.6	29.6	32.7	41.7	37.2	12.3	3.51	34.3	36.0	61.2	34.0	31.7	17.0	27.3	0															
Shamburg	21.7	22.5	26.1	29.6	5.0	34.0	26.1	4.6	15.5	10.5	17.5	20.0	15.5	34.7	26.3	13.9	28.0	33.5	7.7	2.0	40.3	9.5	7.3	2.7	3.5	30.5	4.2	4.6	3.3	23.5	8.2	7.3	22.5	22.3	38.9	0														
St. Petersburg	51.2	31.6	14.0	5.7	25.0	53.7	3.1	30.9	18.1	32.7	12.3	45.7	11.6	19.2	50.0	25.3	41.0	7.5	19.9	26.6	19.7	18.1	19.6	28.6	24.2	4.2	23.7	22.1	24.5	47.5	20.0	20.2	12.0	11.3	18.9	26.7	0													
Spartansburg	7.5	28.0	43.6	47.6	21.3	23.8	43.4	14.8	29.9	18.9	33.9	12.4	33.4	48.8	21.6	28.3	27.1	50.5	24.5	17.5	58.0	26.1	25.0	16.7	21.0	47.9	20.5	22.0	19.9	15.7	25.9	24.0	38.0	40.0	54.9	18.0	44.2	0												
Townville	17.0	13.8	40.4	41.0	20.4	18.5	34.8	16.4	19.3	23.5	24.5	24.8	27.6	36.2	33.8	29.4	14.0	41.3	17.9	14.0	53.5	18.7	20.5	16.7	19.0	39.3	15.0	17.2	15.0	28.0	22.9	17.3	27.6	35.9	44.0	15.5	36.3	14.1	0										
Titusville	20.3	20.4	31.4	34.4	9.8	29.0	30.1	5.3	17.5	12.5	20.8	18.0	30.3	36.8	26.0	18.5	24.5	37.3	11.3	4.5	45.5	12.7	12.0	5.7	8.7	34.7	7.5	9.0	6.7	21.0	13.5	10.7	25.3	27.5	42.0	5.2	31.0	13.6	11.3	0								
Tidioute	20.5	35.5	31.5	38.3	12.5	40.0	37.4	9.9	28.4	4.0	30.9	10.0	25.6	48.3	13.0	14.0	39.0	44.3	21.0	15.2	45.7	22.5	18.5	11.0	14.1	41.1	18.0	17.9	17.2	10.9	17.2	20.7	35.5	29.2	51.2	13.7	37.0	17.2	24.7	14.6	0							
Tionesta	31.3	31.3	18.5	24.9	5.1	43.9	24.6	11.0	20.5	9.0	19.5	23.0	12.5	37.3	26 0	4.0	37.5	31.5	12.2	11.5	33.0	13.1	8.2	9.5	6.7	28.1	11.7	10.0	11.5	24.2	5.3	12.0	24.6	15.7	38.7	10.0	24.0	25.5	25.5	14.7	13.5	0						
Trunkeyville	24.5	34.5	26.6	34.0	9.2	42.0	35.3	6.1	26.7	2.0	27.2	14.5	21.2	45.0	17.0	9.3	39.0	40.2	18.1	13.7	17.1	19.6	15.1	9.5	11.1	37.1	16.9	15.0	15.1	15.3	13.5	18.0	32.2	24.5	47.1	12.0	32.9	20.5	25.2	14.5	4.5	9.0	0					
Triumph	20.3	33.4	30.6	37.1	10.9	38.6	35.9	7.8	27.5	3.2	28.9	10.5	24.0	46.4	14.8	13.4	37.1	42.7	19.2	13.5	45.0	20.7	16.7	9.0	12.5	39.7	16.2	16.0	15.2	12.0	15.7	18.7	34.0	28.0	49.5	12.0	35.7	16.5	23.0	12.7	2.0	12.2	4.2	0			
Utica	36.7	7.0	33.5	30.0	23.0	30.5	22.0	23.7	7.5	30.0	12.7	37.5	20.7	19.6	45.2	30.5	16.5	27.2	14.5	18.0	44.0	13.7	18.5	22.5	20.7	26.3	15.7	17.0	16.5	40.7	21.5	14.5	30.2	29.0	28.1	19.7	24.6	29.7	16.5	19.5	33.3	26.6	31.6	31.5	0			
Union	10.0	28.0	52.0	54.3	29.6	15.3	49.3	23.4	34.0	28.3	39.1	21.5	40.5	51.5	30.0	37.4	24.0	55.7	30.7	24.9	65.9	32.2	32.2	25.1	28.7	53.7	27.2	29.1	26.7	24.3	33.7	30.2	42.3	47.9	58.7	25.6	50.2	9.7	15.0	20.5	26.9	34.2	30.0	26.1	31.6	0		
Venango City	33.6	18.9	22.0	22.0	11.1	37.3	16.8	14.8	6.8	19.4	7.8	30.3	9.0	24.9	36.1	17.5	27.0	24.0	2.3	9.5	34.6	0.7	5.5	12.7	9.2	21.3	6.2	5.5	7.0	32.5	8.2	2.9	12.5	17.5	29.0	10.0	18.0	26.5	18.9	13.5	23.2	13.6	20.2	21.5	13.3	32.5	0		
Waterloo	40.8	11.8	30.4	25.8	23.3	35.6	17.3	25.4	5.8	31.1	9.3	40.1	18.0	15.4	47.2	30.0	21.3	22.3	14.3	19.6	39.8	13.2	18.0	23.7	21.2	21.7	16.7	17.4	17.5	43.0	20.7	14.5	8.5	25.8	23.4	20.7	20.1	33.4	21.1	21.8	34.8	26.2	31.3	33.0	5.0	36.1	12.5	0	
West Spring Creek	6.3	33.7	43.5	48.7	21.7	29.5	45.6	15.2	33.5	17.0	3.66	6.5	34.7	52.6	15.7	27.1	33.5	52.9	27.0	19.7	58.3	28.6	26.7	17.5	22.0	50.0	23.0	24.2	22.3	9.9	26.7	26.6	41.3	40.6	58.0	19.5	46.2	6.0	19.7	16.0	14.1	25.2	18.1	14.0	34.5	14.5	29.3	37.7	0	
Youngsville	17.3	44.5	43.5	57.0	25.1	42.4	50.1	20.9	41.6	17.1	4.30	6.9	38.3	60.3	2.9	26.1	45.9	57.2	33.1	26.6	57.7	34.8	31.2	23.9	26.5	54.1	29.6	30.0	28.8	3.4	30.0	32.6	48.0	41.9	63.9	26.1	50.0	19.1	31.8	24.4	12.8	26.2	17.0	14.2	43.7	27.1	35.4	46.0	1.30	0

LAKE HURON

LAKE MICHIGAN

UPPER CANADA

LAKE ONTARIO

NEW YORK

LAKE ERIE

Meadville

Franklin

PENNSYLVANIA

Pittsburg

Long I.

Sandy Hook

OHIO

INDIANA

Missouri River

Marietta

Parkersburg

Washington

Delaware Bay

Chesapeake Bay

VIRGINIA

Lexington

Ohio River

Greensburg

Danville

KENTUCKY

THE RANGE IN WHICH OIL HAS BEEN FOUND

TENNESSEE

River

Mt Minyeitte

Mississippi

GULF OF MEXICO

ATLANTIC OCEAN

Explanation

The Primitive

The Secondary

The Transition

Map A.

Showing the General Geological Formations of the

UNITED STATES

and the Belt

in which Oil has been found

by

Henry E. Wrigley

Civil Engineer



PREFACE.

The writer has undertaken this small work for the purpose of presenting a nucleus, around which may be gathered practical data, useful in a very important branch of mining, manufacture and commerce; and also as a means of blending the information on each separate head, among all engaged in the trade. Likewise to have at hand for ready reference, such practical and tabled information as may be applicable to the work of this section.

It has been his province, during a residence of eight years in this country, to deal in one direction simply with useful facts, and he trusts that the reception of these memoranda will enable him to add to them still more materially in the future.

He has endeavored to select them with great discrimination, for he considers that figures are both alluring and deceptive. It is but human nature, in estimating results, to throw the benefit of all doubts in the scale of some favored project.

Investigation has always its positive and negative poles; no spark of fact can be elicited until both are joined, or both sides impartially considered.

The subjects embraced have heretofore suffered much from immature reasoning. They were comparatively without past precedent, and open to the random opinions of every dabbler in science.

Most of the tables and other statistics given, have been prepared by careful calculation, or reduced by the same means from the best authorities bearing upon the subject.

To any one looking for a complete treatise upon the production and consumption of oil, the work will undoubtedly seem unfinished and disconnected.

It is, however, intended primarily for the use of business men in all branches of the trade, and as such must be necessarily condensed, and free from even auxiliary subjects.

If it will enable any interested in the subject of Petroleum to conduct their work with increased general comprehension, it will be considered a gratifying result.

TITUSVILLE, January, 1872.

MAP B.

Showing the area and relative position of the producing Spots in the Counties of Erie, Crawford, Warren, Forest, Clarion, Butler, Lawrence, Armstrong, Mercer and Venango.

forming the

PENNSILVANIA OIL REGION.

Engraved from the Large Map

— by —

HENRY E. WRIGLEY C.E.

Entered according to Act of Congress in the year 1876 by Henry E. Wrigley in the Office of the Librarian of Congress at Washington D.C.

Notes. The dark spots upon the Map denotes the outline of each separate territory that has been or is now producing.

Pipe lines indicated by a fine line.

Lith. by A. Vallendar & Co. Cleveland, O.

ERIE

CRAWFORD

WARREN

FOREST

MERCER

VENANGO

CLARION

BUTLER

Corry
Meadville
Titusville
Petroleum Centre
Oil City
Franklin
Pithole
Pithole City
Parkers Landing
St. Petersburgh
Clarion
Butler

GEOLOGICAL NOTES.

The geology of the oil country is a subject upon which so many theories have been wrecked, that it is not without considerable hesitation that any attempt is made to state even what are supposed to be accepted facts. It is not purposed here to put forth any particular views of the writer, but to arrange, in a simple way and without technical expressions, the few main features of the subject, as part of a foundation upon which may be built, in the future, a more detailed exposition of the whole matter.

It is well known that the Allegheny Mountains divide the United States geologically as well as geographically; that east of them lie the transition, the primitive and the alluvial formations, and west of them the great secondary formation, or formation by deposition from water. (*See Map A.*)

This secondary formation extends across the continent, from the Alleghenies to points far west of the Mississippi.

Whether the great valley, drained by the Mississippi, was once swept over by an ocean, of which the great lakes are but the remaining puddles, is not an object of immediate interest. That the Alleghenies formed the shore or beach of some such body of water, that along its edge were strewed animal and vegetable remains, it is undoubtedly safe to assume.

The presence of carbon, as the base of oil, shows that these deposits were either animal or vegetable; it being the base of the animal and vegetable world, as silica is of the mineral world.

Of course the drill does not reach these deposits. They lie perhaps almost uniformly under this edge of the formation, at a depth of from 30,000 to 40,000 feet.

The heat at this depth, although only a matter of estimate, is doubtless very great, as we know that between 150 and 2,000 feet in depth, there is an increase of 30°.

It would seem, then, that these deposits of animal or vegetable matter are volatilized and thrown off into the upper rocks, and condensed there, by the lower temperature, into the liquid oil.

Into what rock the gas will enter, will depend upon the character of the rock. A close slate or sandstone will resist it, but wherever it finds a crevice or an open porous rock, it will force its way into it and condense there.

Consequently the rock itself is the guide of the driller in searching for oil, and the location of the oil-producing spots, resolves itself into that of the existence of this porous sand rock. (*See Map B.*)

All the oil-producing spots that have been found in this section of the United States, are included in a belt of twenty miles in width, stretching from Western New York to Tennessee, in a line parallel with the Alleghenies, and lying about fifty miles to the west of them. This belt is defined on Map A. The producing spots themselves are in area but the smallest specks upon this belt, and are scattered over it in such an indiscriminate manner, that it is impossible to trace any connection between them, or, rather, to deduce the position of one producing spot from others, with any degree of satisfaction. Map B shows the producing spots in that portion of the whole belt comprised in the Pennsylvania Oil Region. (For an enlarged view of the same see large maps published by the writer.) It is equally impossible to trace any connection between these spots and the water-shed or river drainage of the country.

A matter which will somewhat affect the question of oil production at the south end of the belt, is the dip of the sand rock deeper into the earth as it goes south. Although this is in a great measure counteracted by the general slope of the water-shed of the country in that direction, it will still average, as near as can be ascertained by leveling and drilling, about thirty inches to the mile.

One great fact stands prominently forward in the results of all investigation into this matter: that we are yet in the infancy of oil development, and that it will still be found in vast quantities along this range for many generations yet to come.

Professor Silliman says that "Petroleum is uniformly regarded as a product of vegetable decomposition."

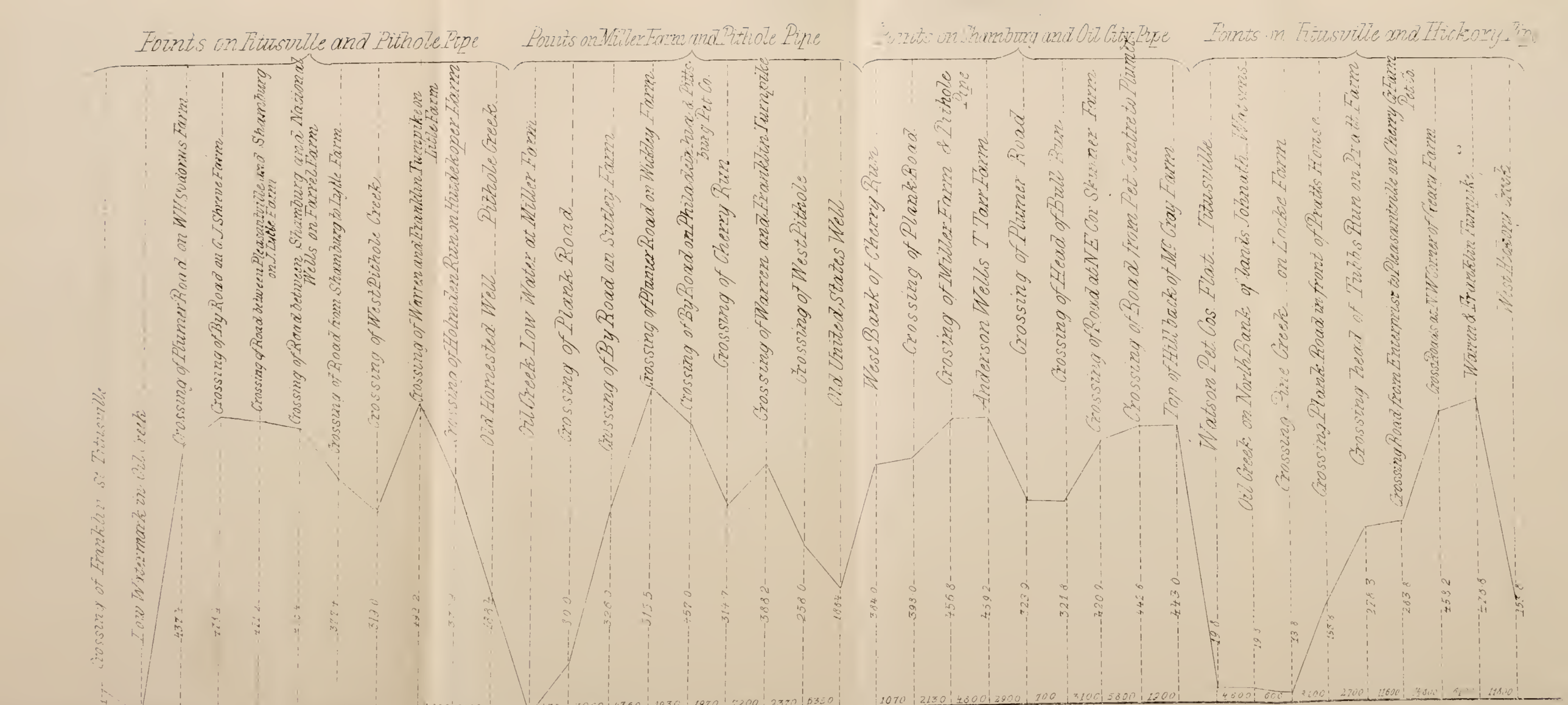
Professor Dana says "Petroleum is a bituminous liquid resulting from the decomposition of marine or land plants, (mainly the latter), and perhaps also of some non-nitrogenous animal tissues."

Professor Denton says "It is a coral oil, not formed from the bodies of the coral polyps, as some have supposed, but secreted by them from the impure waters, principally, though not exclusively, of the Devonian times."

The sand stone beds in which the oil is found, belong to the Chemung group of the Devonian formation. It is so called from the Chemung river, in the state of New York, where it is well exhibited.

TEMPERATURE OF THE EARTH AT DIFFERENT DEPTHS AS ASCERTAINED FROM THE ARTESIAN WELL, AT GRENELLE IN FRANCE.

150 feet	- - - - -	53° Fahr.
1326 "	- - - - -	74° "
1650 "	- - - - -	79° "
1806 "	- - - - -	81° "


Points on Titusville and Pithole Pipe
Points on Miller Farm and Pithole Pipe
Points on Shamburg and Oil City Pipe
Points on Titusville and Hickory Pipe
Crossing of Franklin St Titusville
Low Watermark in Oil Creek
Crossing of Plumer Road on W H Watkins Farm
Crossing of By Road on G J Shreve Farm
Crossing of Road between Pleasantville and Shamburg on Little Farm
Crossing of Road between Shamburg and Nazareth Wells on Farrel Farm
Crossing of Road from Shamburg to Lytle Farm
Crossing of West Pithole Creek
Crossing of Warren and Franklin Turnpike on Little Farm
Crossing of Holmden Run on Hudekoper Farm
Old Homested Well
Pithole Creek
Oil Creek Low Water at Miller Farm
Crossing of Plank Road
Crossing of By Road on Sutley Farm
Crossing of Plumer Road on Widdy Farm
Crossing of By Road on Philadelphia & Pittsburg Pet Co.
Crossing of Cherry Run
Crossing of Warren and Franklin Turnpike
Crossing of West Pithole
Old United States Well
West Bank of Cherry Run
Crossing of Plank Road
Crossing of Miller Farm & Pithole Pipe
Anderson Wells T Tour Farm
Crossing of Plumer Road
Crossing of Head of Bull Run
Crossing of Road at NE Cor Skinner Farm
Crossing of Road from Pet Centre to Plumer
Top of Hill back of Mc Coy Farm
Watson Pet Co Flat Titusville
Oil Creek on North Bank of Lands Johnath Watsons
Crossing Pine Creek on Locke Farm
Crossing Plank Road in front of Potts House
Crossing Head of Tubbs Run on Drake Farm
Crossing Road from Enterprise to Pleasantville on Cherry Grove Farm Potts
Cross Runs at NW Corner of Geary Farm
Warren & Franklin Turnpike
West Hickory Creek
Distance in feet
5500 3100 5500 5000 3300 2000 3100 3600 5700 435 3060 4360 1930 1970 7200 2370 5350 1070 2130 4800 2900 700 3100 5800 1200 4800 600 3100 2700 1600 4800 1800
0 30 437 2 771 4 511 4 504 377 4 519 0 432 2 377 4 683 2 50 0 326 3 515 5 552 0 314 7 388 2 258 0 188 4 384 0 393 0 456 8 459 2 723 9 321 8 420 2 442 6 443 0 19 8 19 3 23 8 158 3 274 3 263 8 453 2 278 8 155 8

A TABLE OF COMPARATIVE LEVELS.

of 38 separate localities

lying between Titusville, Pithole and Oil City.

Lith. by A. Vallendar & Co. Cleveland O.

TABLE OF SOME WELL RECORDS IN DIFFERENT PARTS OF THE OIL REGION.

Name of Well.	Farm.	Township.	County.	Whole Depth.	1st Sand at	Thickness.	2d Sand at	Thickness.	3d Sand at	Thickness.	4th Sand at	Thickness.	5th Sand at	Thickness.
A. & G. W. Oil Co.		Oil Creek,	Crawford	642					573	64				
Cadwallader & Warner		"	"	613			524		557					
C. G. Emery		Southwest,	Warren,	474					446		462			
Myers & Sherman		"	"	465	238		342		450	12				
E. Baum	Baum,			844							699		797	
William Wood	Zuver,	Oil Creek,	Venango,	844	362	18	534	14	628	21	772	23	799	8
H. Davies	Steel,			526	313	31			475	20				
J. Watson		Perry,	Armstr'g	803			400		757					
"		"	"	900			400		452	37				
Murphy & McKenny	Hall,			559			382		520	23				
J. Watson	Ball,			868	587	77			834					
E. Poor & Co	Poor,			830							708	31		
Custer & Lowers	Bennehoff,			858									824	28
Dr. Egbert	Egbert,	Cornplanter,	Venango,	564	267		387	22	517	32				
"	Skinner,	"	"	791			605	24	764					
J. Watson	Weed,	Oil Creek,	Crawford	704	364		597		633					
B. D. Benson		Southwest,	Warren,	722					609		671		711	
"		"	"	596	241	27	325	19	369	13	418	16	482	
Whitman & Doubleday	McClintock,	Cornplanter,	Venango,	652	330		485	14	546	15	596			

Cranberry Oil Co.		Southwest,	Warren,	481					442		22								
Fee & Emery		"	"	560			372	8	509		35								
Haines, Gay & Co.		"	"	522	221		342	10	469		20								
Watson, Williams & Barnsdall,	Barnsdall,			767	463		672		752			765							
A. R. Williams				579	275	44	429		560										
Fisher Bros.	Econ. Tract,	Limestone,	Warren,	543					521		17								
Coe & Scrimby	"	"	"	334	207		241	26	301										
Beatty & Sons		Durfield,	"	439			305	40	415										
"		"	"	472			344	28	416		27								
F. G. Irving	Blood,	Cornplanter,	Venango,	874					558		51	693	40						
Col Roberts		Oil Creek,	"	823					779			794		813					
James Burns				634			472	20	597										
Reno Oil Co.		Sugar Creek,	Venango,	882					668		15								
H. Joy & Co.		Southwest,	Warren,	522	221		342	10	469		19								
Benedict Estate		"	"	482					460		14								
Fee & Emery	C'rp'nt'r Lot			560			372	8	509		35								
Watson, Williams & Barnsdall,	Barnsdall,			767	463		672		752		13								
A. R. Williams				579	275	44	429		560										
Redfield & Co.	Sheridan,			778			542		688					706					
W. Barber		Cornplanter,	Venango,	518	208		342	35				489	24						
W. H. Marsden		"	"	477	200	31	333		364		7								
D. Kinney	Kinney,			591	247		500		531										
T. King	Withrop,			632	330	14	435	55	607		20								
C. Angell		Rockland,	Venango,	660	365	5	469	59	635										
J. W. Brice				811	316	26			717		47			791	19				
G. T. Ridgway	McMullen,			739			586		721										
E. Haines	Benedict,			495					480		10								
T. Chattels	N. Star Co.,			667					626		16								
Watson & Steele	Terrill,			796					620		37	775							
R. W. Throwbley	Shaw,	Cornplanter,	Venango,	789	497	43	614		763		23								

TABLE OF SOME WELL RECORDS IN DIFFERENT PARTS OF THE OIL REGION.

(CONTINUED.)

Name of Well.	Farm.	Township.	County.	Whole Depth.	1st Sand at	Thickness.	2d Sand at	Thickness.	3d Sand at	Thickness.	4th Sand at	Thickness.	5th Sand at	Thickness.
	Tarr Farm,	Cornplanter,	Venango,	975	213	35	437	42	653	42	781	33	940	14
	Bastian "	Cranberry,	"	550	230	30	365	35	485	30	.....	..	.....	..
	Moran "	Cornplant'r & Cranb'ry,	"	550	202	29	352	25	469	40	.....	..	.....	..
	" "	" "	"	520	225	35	360	30	475	30	.....	..	.....	..
	Piagett "	Cornplanter,	"	500	215	25	350	50	475	25	.....	..	.....	..
	Farren "	Cranberry,	"	525	225	30	360	35	475	30	.....	..	.....	..
	.....	.....	.....	545	240	30	360	30	515	15	.....	..	.....	..
	Hayes Farm	Cranberry,	Venango.	525	240	25	360	25	485	25	.....	..	.....	..
	Reno O. Co.,	Sugar Creek,	"	600	230	20	400	25	550	10	.....	..	.....	..
	Huff "	Cranberry,	"	550	223	32	370	32	495	30	.....	..	.....	..
	.....	.....	.....	350	240	32	320	40	.....	..	.....	..	.....	..
	Martin,	Sugar Creek,	Venango,	500	280	40	510	30	.....	..	.....	..	.....	..
	Booth Farm Oil Co,	Cranberry,	"	500	330	20	440	20	.....	..	.....	..	.....	..
	Fuller,	"	"	500	60	4	470	9	.....	.....	.....	..	.....	..
	Ch'y Tree Run O. Co	Cherry Tree,	"	606	.....	..	458	32	574	..	.....	..	.....	..
	Canton "	Southwest,	Warren,	533	482.6	..	.....	..	502	30	.....	..	.....	..
McKenny.....	Calden "	"	"	475	.....	..	.....	..	440.7	..	458	..	.....	..
Watson & Canfield.....	.....	Alleghany,	Venango,	719	...	..	290	..	628.9½	29	685	..	.....	..
J. Watson.....	Gt. Republic	.....	.....	794	...	..	.....	..	.....	..	.....	..	.....	..

Dr. Holbrook	Holbrook,			789			317		547		670		755	24
Brown Bros		Deerfield,	Warren,	477			363	11	447					
Warren & Venango Oil Co				446	113	19	303	40	418					
Merkle	Econ. Tract,	Limestone,	Warren,	571	360		479		544	27				
Brown Bros		Deerfield,	"				363		447					
Fisher Bros	Economy,	Limestone,	"	485	327	20			467					
Hart, Andrews & Co				485			444		453		463			
W. Barber		Cornplanter,	Venango,	518	208		342	35	489	27				
T. King	Withrop,			632	360		435	50	607	20				
Jno. W. Boyle	Armstrong,	Oil Creek,	Venango,		316	18			717	39	791	19		
N. Star Oil Co	Bepnecker,			667					626	18				
R. W. Funda	Shaw,	Cornplanter,	Venango,	789	497	43	614		763	15				
Holbrook	Ball,	"	"	789	371				547		681		755	
	Blood,	"	"	884	558		609		631		733		874	
Jas. Burns				826			472	20	597		793		813	
Collins Bros		Oil Creek,	Venango,	844	362	18	534	14	628	12	772	23	799	8

BOILERS AND ENGINES.

In arranging for the use of steam in connection with any work, it is worth while to remember that the boiler is the SOURCE *of all power*. Black and clumsy as it may appear to a superficial observer, its deficiency cannot be overcome by the most careful attention, or the most perfect machinery.

The breaking weight of boiler plates is the same either across or with the direction of the fibre.

Assuming the strength of the boiler plate itself to be..... 100

The strength of a double riveted joint is..... 70

of a single riveted joint is..... 56

TABLE OF EQUAL STRENGTHS IN CYLINDRICAL BOILERS FROM 3 TO 8 FEET DIAMETER, SHOWING THE THICKNESS OF METAL IN EACH, RESPECTIVELY, AT A PRESSURE OF 450 LBS. PER SQUARE INCH.

Diameter. ′ ″	Thickness of Plates in decimals of an inch.
3.0	.250
3.6	.291
4.0	.333
4.6	.376
5.0	.416
5.6	.458
6.0	.500
6.6	.541
7.0	.583
7.6	.621
8.0	.666

TABLE OF THE COHESIVE STRENGTH OF BOILER IRON AT DIFFERENT TEMPERATURES.

32° to 80°,	the tenacity was	56000 lbs.
570° to 0°,	" "	66500 lbs. the maximum.
720° to	" "	55000 lbs.
1050°	" "	32000 lbs.
1240°	" "	22000 lbs.
1317°	" "	9000 lbs.

3000° iron becomes fluid.

The tenacity of the iron increasing as its temperature was raised until it reached a temperature of 550° above

freezing point, at which point its tenacity began to diminish.

Temperature at which clean iron will evaporate water is 334° F.

When the plate is hotter than this, the water is not so readily vaporized, as a species of *repulsive action* occurs. For instance, drops which require one second to disappear at a temperature of 334° required 152 seconds to disappear at a temperature of 395°. These results, however, would be modified by increasing the quantity of water.

In order to raise steam with economy, the surface of water in the boiler exposed to the fire, ought not to be less than ten square feet per horse-power.

One pound (avoirdupois) of water contains 27.72 cubic inches.

One cubic inch of water forms 1696 cubic inches of steam at 212°.

Therefore one pound of water will form 27.31 cubic feet of steam at 212°

Steam in contact with water is at its maximum density.

The constituents of water by weight and measure are,

By weight.	By measure,
Oxygen, 88.9	1
Hydrogen, 11.1	2

One cubic inch of water (distilled) at its maximum density of 39°.83, the barometer at 30 inches, weighs 252.6937 grains, and is 828.5 times heavier than atmospheric air.

A cubic foot weighs 998.068 ounces, or 62.37925 lbs. avd. For facility of computation, a cubic foot is taken at 1000 oz., and 62.5 lbs. At a temperature of 212° its weight is 59.675 lbs.

Below 39°.83 its density decreases at first very slowly but progresses rapidly to the point of congelation, the weight of a cubic foot of ice being but 57.25 lbs. It expands $.089 = \frac{1}{11.24}$ of its bulk in freezing.

From 40° to 12° it expands .00236 of its bulk, and from 40° to 212° it expands $.04012 = .00023325$ for every degree, giving an increase in volume (from 40° to 212°) of $\frac{1}{.04012} = 1$ cubic foot in 24.92 ft.

Height of a column of water at 60° equivalent to the pressure of { 1 lb. per sq. inch, is 2.306 ft. / The atmosphere is 33.949 ft.

35.84 cubic feet water weigh one ton.

39.13 " " ice " " "

ENGINES. HORSE POWER.

The horse-power of engines is designated in two ways: 1st, as nominal, or calculated with a uniform pressure and velocity. 2nd, as actual, or effective horse-power, calculated from the real performance of the engine.

To ascertain the nominal horse-power of an engine,—(non-condensing,) based on a uniform pressure of 60 lbs. per square inch, (steam gauge,) cut off at half the stroke, deducting one-sixth for friction and losses, and with a mean velocity of 250 feet per second—we have the formula: $\frac{d^2 v}{1000}$ = horse-power.

d = diameter of cylinder in inches.

v = velocity of the piston in feet per minute.

TABLE OF NOMINAL HORSE-POWER, COMPUTED FROM ABOVE FORMULA.

Diameter of Cylinder in inches.	Stroke of Piston in feet.	Revolutions pr. Minute.	Horse-Power.
6	1.0	125	9.
6	1.5	85	9.2
7	1.0	125	12.2
7	1.5	85	12.5
8	1.5	85	16.3
8	1.75	75	16.9
9	1.5	87	21.1
9	1.75	75	21 3
9	2.0	66	21.4
9	2.5	53	21.5
10	1.5	87	26.1
10	1.75	76	26.6
10	2.0	68	27.2
10	2.5	55	27.5
10	3.0	47	28.2
10	3.5	41	28.7
10	4.0	36	28.8
11	2.0	70	33.9
11	2.5	55	33.3
11	3.0	46	33.4
11	3.5	40	33.9
11	4.0	36	34.9
12	2.0	68	39.2
12	2 5	55	39.6
12	3.0	47	40.6

To ascertain the actual or effective power of an engine, (non-condensing,) we have the following formula :

A=area of cylinder in square inches.

P=mean effective pressure upon cylinder piston in lbs., per square inch, inclusive of atmosphere.

f=friction of the engine in all its parts added to the friction of the load, in lbs., per square inch.

s=stroke of the piston in feet.

r=revolutions per minute.

then—

$$\frac{A \times \overline{P-(f+14.7)} \times 2sr}{33000} = \text{horse-power.}$$

The value of f may be safely estimated at 2.5 lbs. per square inch for the friction of the engine in all its parts, and the friction of the load may be taken at 7½ per cent. of the remaining pressure.

EXAMPLE.

With an engine having a cylinder of 10 inches, stroke four feet, making 45 revolutions per minute, and steam-gauge indicating 60 lbs., we should have—

A=78.54 sq. inches.

P=60+14.7=74.7 lbs.

f=2.5+(60+14.7—2.5)×.075=7.92 lbs.

$$\text{Then } \frac{78.54 \times (60+14.7-7.92+14.7) \times 2 \times 4 \times 45}{33000} =$$

44.6 horse power.

A shorter method of calculating horse-power, is to use the unit of 550 lbs. moved one foot per second, instead of 33000 lbs. one foot per minute.

FUEL.

The fuel in common use in this section is either coal or wood.

Of wood fuel it may be observed, that the quantity of moisture in a newly-felled tree is from 20 to 50%. Birch contains 30, Oak 35, Pine 39. There is never less than 10% present, even when it has been kept for a long time in a dry place.

For every 14 parts of an ordinary pile of wood there are 11 parts of space, or a cord of wood in pile has 71.68 feet of solid wood and 56.32 feet of space.

TABLE OF COMPARATIVE POWERS OF WOOD AND COAL.

Combustible.	Lbs. of Water which 1 lb. can Heat, from 0° to 212°	Lbs. of Boiling Water Evaporated by 1 lb.	Weight of Atmospheric Air at 32° to burn 1 lb.
Perfectly dry Wood,	35.00	6.36	5.96
Ordinary Wood, -	26.00	4.72	4.47
Coal, - - - - -	60.00	10.90	9.26

From 15 to 20% of the heating power of coal is due to its volatile ingredients, hydrogen and oxygen.

The least consumption of coal yet attained is $1\frac{1}{2}$ lbs. per hour per indicated horse-power. It usually varies in different engines from 2 to 8 lbs.

COMPOSITION OF COAL.

	Carbon.	Hydrogen.	Oxygen and Nitrogen.	Ash.	Economical Value of 100 parts.
Cannel, -	83.75	6.49	10.86	0.13	262
Anthracite,	91.98	3.92	3.16	0.94	273

TABLE OF LBS. OF ANTHRACITE COAL USUALLY CONSUMED PER DAY OF 12 HOURS PER HORSE-POWER.

H. P.	LBS.	H. P.	LBS.	H. P.	LBS.	H. P.	LBS.
4	168	26	1092	46	1933	66	2772
6	252	28	1176	48	2016	68	2856
8	336	30	1260	50	2100	70	2940
10	420	32	1344	52	2184	72	3024
12	504	34	1428	54	2268	74	3108
14	588	36	1512	56	2352	76	3192
16	672	38	1596	58	2436	78	3276
18	756	40	1680	60	2520	80	3360
20	840	42	1764	62	2604	82	3444
22	924	44	1848	64	2688	84	3528
24	1008						

TO DETERMINE THE TEMPERATURE OF A FIRE.

Steel becomes a very faint Yellow	- - - -	at 430° Fahr.
a pale Straw color	- - - -	" 450° "
a full Yellow	- - - - -	" 470° "
Brown	- - - - -	" 490° "
Brown with Purple Spots	- -	" 510° "
Purple	- - - - -	" 530° "
Blue	- - - - - -	" 550° "
Full Blue	- - - - -	" 560° "
Dark Blue, almost Black,	- -	" 600° "

OF THE USE OF HYDRO-CARBONS FOR FUEL.

On this subject, which is one doubtless still worthy of some consideration, the following deductions from the experience of the past few years may prevent much useless labor.

1st. No complicated invention is necessary to effect a perfect combustion of liquid fuel. A very simple arrangement of a pan with covers, and a steam jet properly introduced, will accomplish all that can possibly be desired.

2nd. The best results that have yet been reliably obtained in this matter, with ordinary boilers, show the relative heating power of Petroleum to be about $2\frac{1}{2}$ times that of Anthracite Coal; or that oil at $3 per barrel is as economical as coal at $10 per ton.

3rd. The apparently intense heat of the oil flame is

deceptive as to actual result, as a glance at the steam-gauge will readily show. It lacks the steady body of heat that coal supplies.

4th. That such a strong draft is required for this fuel, that much of the heat often passes into the air, and any attempt to remedy this by return flues causes a deposit of carbon which detracts not only from the vital substance of the fuel, but obstructs the transmission of its heat.

That a boiler might be constructed to remedy these points is unquestionably possible,—that the result attained would ever overcome the difference in cost of the fuels is not so probable.

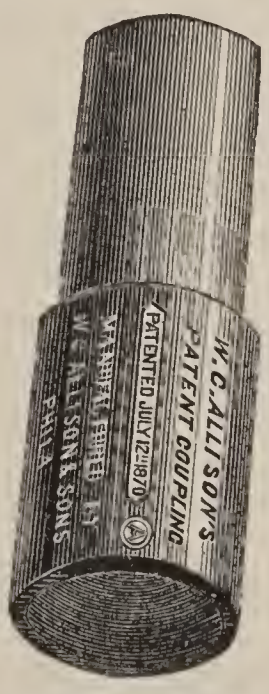
TUBING.

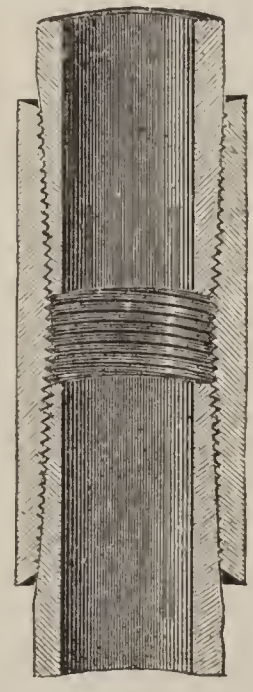
The tubing that is in use for well and shipping purposes, is generally made of wrought iron plates of number 6 or 7 wire gauge, heated in a furnace and turned over a round bar, the joint, in lap-weld tubing, being formed by passing it, while hot, through a combination of rollers, which turn up the edges and then press or weld them down upon each other.

In butt-weld tubing, the edges are simply made very hot, and then joined in the rollers.

Tubing, to be merchantable for oil purposes, must stand a test of 1,200 lbs. per square inch of internal pressure.

The connecting joints of the tubing have been the subject of considerable study; it having been found that the ordinary thread cut upon the end of each length had a tendency to leave a weak spot at the termination of the thread, just outside the thimble, where it was easily affected and often broken by the jar caused in pumping.





Mr. Allison's tapering thread, and thimble to correspond, as shown in the cut, is perhaps the best remedy for this. The depth of the thread being lessened as it recedes from the end of the tubing, adds the principle of

the wedge to that of the ordinary screw joint, without lessening, at any point, the full strength of the material.

STATISTICS OF TWO INCH TUBING.	Inches.
Actual outside diameter	2.374
Thickness of metal	0.154
Actual inside diameter	2.067
Internal circumference	6.494
External circumference	7.461
Length of pipe per square foot of inside surface	ft. 1.848
Length of pipe per square foot of outside surface	" 1.611
Internal area of section	in. 3.355
External area of section	" 4.430
Length of pipe containing one cubic foot	ft. 42.36
Weight per foot in length	lbs. 3 667
No. of threads per inch of screw	11½
Taper of threads on each side	1 to 32
Length of pipe containing one gallon	ft. 5 636

TANKS.

TO ASCERTAIN THE INTERNAL PRESSURE OF THE FLUID CONTAINED.

TO ASCERTAIN THE PRESSURE ON THE BOTTOM OF THE TANK.

Multiply the area of the bottom in feet, by the height of the stave or side, and the product by the weight of a cubic foot of the fluid.

TO ASCERTAIN THE PRESSURE ON THE SIDES OF A TANK WHEN PERPENDICULAR.

Multiply the circumference of the tank by its height to obtain the area of the sides; multiply this area by half the height of the tank, and this product by the weight of a cubic foot of the fluid.

Oil of 45° gravity weighs 50.37 lbs. per cubic foot. (See table in Refining.)

When the sides of the tank are sloping, the mean circumference will be taken.

The pressure of the fluid upon any part of the vertical side of a tank, is proportionately as the square root of its distance from the surface.

In the construction of iron tanks the tables of strengths of boiler plates and riveted joints for relative pressures will be found useful.

Contents of One Inch in Height for Various Diameters of Cylindrical Tanks.

Diameter.	Circum.	Area.	Galls.	Diameter.	Circum.	Area.	Galls.
Ins.	Inches.	Sq. Inches.		Ins.	Inches.	Sq. Inches.	
6	18.849	28.274	.122	48	150.797	1809.562	7.834
7	21.991	38.485	.167	49	153.938	1885.745	8.163
8	25.133	50.266	.218	50	157.08	1963.5	8.5
9	28.274	63.617	.275	51	160.222	2042.825	8.843
10	31.416	78.54	.34	52	163.363	2123.722	9.194
11	34.558	95.033	.411	53	166.505	2206.189	9.551
12	37.699	113.098	.490	54	169.646	2290.226	9.914
13	40.841	132.733	.575	55	172.788	2375.835	10.285
14	43.982	153.938	.666	56	175.93	2463.014	10.662
15	47.124	176.715	.765	57	179.071	2551.765	11.047
16	50.266	201.062	.870	58	182 213	2642.086	11.438
17	53.407	226.981	.983	59	185.354	2733.977	11.835
18	56.549	254.470	1.101	60	188.496	2827.44	12.24
19	59.69	283.529	1.227	61	191.638	2922.473	12 651
20	62.832	314.16	1.36	62	194.779	3019.078	13.070
21	65.974	346.361	1.499	63	197.921	3117.253	13.495
22	69.115	380.134	1.646	64	201.062	3216.998	13.926
23	72.257	415.477	1.799	65	204.204	3318.315	14.365
24	75.398	452.39	1.958	66	207.376	3421.202	14.81
25	78.54	490.875	2.125	67	210.487	3525.66	15.263
26	81.682	530.93	2.298	68	213.629	3631.69	15.722
27	84.823	572.557	2.479	69	216.77	3739.289	16.187
28	87.965	615.754	2.666	70	219.912	3848.46	16.66
29	91.106	660.521	2.859	71	223.054	3959.201	17.139
30	94.248	706.86	3.06	72	226.195	4071.514	17.626
31	97.39	754.769	3.267	73	229.337	4185.397	18.119
32	100.531	804.250	3.481	74	232.478	4300.85	18.618
33	103.673	855.301	3.703	75	235.62	4417.875	19.125
34	106.814	907.922	3.93	76	238.762	4536.47	19.638
35	109.956	962.115	4.165	77	241.903	4656.637	20.159
36	113.098	1017.878	4.406	78	245.045	4778.374	20.686
37	116.239	1075.213	4.655	79	248.186	4901.681	21.219
38	119.381	1134.118	4 91	80	251.328	5026.56	21.76
39	122.522	1194.593	5.171	81	254.47	5153.009	22.307
40	125.664	1256.64	5.44	82	257.611	5281.03	22.862
41	128.806	1320.257	5.715	83	260.753	5410.621	23.423
42	131.947	1385.446	5.998	84	263.894	5541.782	23.99
43	135.089	1452.205	6.287	85	267.036	5674.515	24.565
44	138.23	1520.534	6.582	86	270.178	5808.818	25.146
45	141.372	1590.435	6 885	87	273.319	5944.693	25.735
46	144.514	1661.906	7.194	88	276.461	6082.138	26.33
47	147.655	1734.949	7.511	89	279.602	6221.153	26.931

Diameter.	Circum.	Area.	Galls.	Diameter.	Circum.	Area.	Galls.
Ins.	Inches.	Sq. Inches.		Ins.	Inches.	Sq. Inches.	
90	282.744	6361.74	27.54	136	427.258	14526.758	62.886
91	285.886	6503.897	28 155	137	430.399	14741.173	63.815
92	289.027	6647.626	28.778	138	433.541	14957.158	64 75
93	292.169	6792.925	29 407	139	436.682	15174.713	65.691
94	295.31	6939.794	30.042	140	439.824	15393.84	66.64
95	298.452	7088.235	30.685	141	442.966	15614.537	67.595
96	301.594	7238.246	31.334	142	446 107	15836.806	68.558
97	304.735	7389.829	31.991	143	449.249	16060.645	69.527
98	307.877	7542.982	32.654	144	452.39	16286.054	70 502
99	311.018	7697.705	33.323	145	455.532	16513.035	71.485
100	314.16	7854.	34.	146	458.674	16741.586	72.474
101	317.302	8011.865	34.683	147	461.815	16971.709	73.471
102	320.443	8171.302	35.374	148	464.957	17203.402	74.474
103	323.585	8332.309	36.071	149	468.098	17436.665	75 483
104	326.726	8494.886	36.774	150	471.24	17671.5	76.5
105	329.868	8659.035	37.485	151	474.382	17907.905	77.523
106	333.01	8824.754	38.202	152	477.523	18145.882	78.554
107	336.151	8992.045	38 927	153	480.665	18385.429	79.591
108	339.293	9160.906	39.658	154	483.806	18626.546	80 634
109	342.434	9331.337	40.395	155	486.948	18869.235	81.685
110	345.576	9503.34	41.14	156	490.09	19113.494	82.742
111	348.718	9676.913	41.891	157	493.231	19359.325	83.807
112	351.859	9852.057	42 65	158	496.373	19606.726	84.878
113	355.001	10028.773	43.415	159	499.514	19855.697	85.955
114	358.142	10207.058	44.186	160	502.656	20106.24	87.04
115	361.284	10386.915	44.965	161	505.798	20358.353	88.131
116	364.426	10568.342	45.75	162	508.939	20612.038	89.23
117	367.567	10751.34	46.543	163	512.081	20867.293	90.335
118	370.709	10935.91	47.342	164	515.222	21124.118	91.446
119	373.85	11122.049	48.147	165	518.364	21382.515	92.565
120	376.992	11309.76	48.96	166	521.506	21642.482	93.69
121	380.134	11499.041	49.779	167	524.647	21904.021	94.828
122	383.275	11689.894	50.606	168	527.789	22167.13	95.962
123	386.417	11882.317	51.439	169	530.93	22431.809	97.107
124	389.558	12076.31	52.278	170	534.072	22698.06	98.26
125	392.7	12271.875	53.125	171	537.214	22965.881	99.419
126	395.842	12469.01	53.978	172	540.355	23235.274	100.586
127	398.983	12667.717	54 839	173	543.497	23506.237	101.759
128	402.125	12867.994	55.706	174	546.638	23778.77	102.938
129	405.266	13069.841	56.579	175	549.78	24052.875	104.125
130	408.408	13273.26	57.46	176	552.922	24328.55	105.318
131	411.55	13478.249	58.347	177	556.063	24605.797	106.519
132	414.691	13684.81	59.242	178	559.205	24884.614	107.726
133	417.833	13892.941	60.143	179	562.346	25165.001	108 939
134	420.974	14102.642	61.05	180	565.488	25446.96	110.16
135	424.116	14313.915	61.965	181	568.63	25730.489	111.387

Diameter.	Circum.	Area.	Galls.	Diameter.	Circum.	Area.	Galls.
Ins.	Inches.	Sq. Inches.		Ins.	Inches.	Sq. Inches.	
182	571.771	26015.59	112.622	192	603.187	28952.986	125.338
183	574.913	26302.261	113.863	193	606.329	29255.365	126.647
184	578.054	26590.502	115.11	194	609.47	29559.314	127.962
185	581.196	26880.315	116.365	195	612.612	29864.835	129.285
186	584.338	27171.698	117.626	196	615.754	30171.926	130.614
187	587.479	27464.653	118.895	197	618.895	30480.589	131.951
188	590.621	27759.178	120.17	198	622.037	30790.822	133.294
189	593.762	28055.273	121.451	199	625.178	31102.625	134.643
190	596.904	28352.94	122.74	200	628.32	31416.	136.
191	600.046	28652.177	124.035				

SURVEYS AND LINES.

One of the first points that call for the attention of the producer, is that of the correct location of the lease or fee-simple upon which his operations are to be conducted.

While the matter is rendered difficult by the latitude given in old surveys, and by imperfect recitations of title, (both arising from the low value in which these lands were formerly held,) there are still certain general facts and principles, which, if thoroughly understood, would often prevent considerable loss and annoyance.

The title to all the land in this section comes originally from the State.

The counties of Crawford, Venango, Warren, Forest, Armstrong, Clarion, Mercer and Butler, were covered by large grants or sales to various parties, which were generally located so as to include all the valuable level table lands and exclude the steep and rugged hill-sides known as the river-tracts.

These river-tracts, together with the unoccupied spaces between the large grants, were afterwards sold and patented by the State directly to separate purchasers. The large grants were divided off and numbered in what are called whole tracts, so that the title to any piece therein refers to the number of the whole tract in which it is situated.

The State lands are described entirely from metes and bounds, courses and distances; a copy of the original survey being always to be found in the Land Office at Harrisburg.

In the location of land from descriptions or surveys, it is all-important to bear in mind the one fact, that *established land-marks* are paramount to everything else.

Development destroys land-marks almost invariably, for the reason that if A has a good well, his neighbor B will put one just as close to the line as he can possibly come, and then A, to protect himself, puts another close to B's.

If a perfectly straight line is drawn between any two old corners, there will be found between the line trees that are most to the left of this line and the line trees that are most to the right of this line, a distance of from ten to twenty feet. When the line trees are gone, a well which was fairly upon B's land, could be shown by the straight line to be upon A's.

If operators would accurately locate and maintain their corners and lines before developments destroy them, and in addition to this, have them carefully noted by the surveyor, so that he can re-locate them and testify to them when they are gone, much future trouble would be avoided.

A very small, insignificant tree may bear a mark, that, to a practical eye, will prove uncontrovertible.

It is essential, if a valuable line or witness tree has been cut down, that the marks should be carefully cut out in the presence of a witness who can note its situation.

These blocks will almost unerringly tell the age of the mark, each ring of the tree counting a year; and from this, the date of the survey, and the survey itself, if on record, can be readily found.

The law of lines cannot be better defined than in the following decision of Chief Justice Gibson in the case of Cox *vs.* Crouch. (8 Barr, p. 147.)

"Where land is described in a deed of conveyance, or in official surveys, by courses and distances, and also by calls of adjoinders, the *latter*, where there is any discrepance, *invariably govern*.

"Natural or artificial landmarks, descriptive of lands conveyed, constitute the true boundaries; and the courses and distance, if added, serve but to point towards the place.

"By reason of imperfection of instruments, as well as inequalities of surface and carelessness of assistants, extreme accuracy is not to be attained by the compass and chain; while, on the other hand, call for natural objects, or, what is much the same, known and established lines of contiguous tracts, admit of perfect certainty.

"When a vendor, therefore, conveys by *established land-marks*, the subject of the grant will neither over-

run nor fall short of them. *They form the true boundary.*"

Attempts are often made to locate land by accurate measurements from established points, without regard to land-marks or efforts to search for them. Measurements alone can only be relied upon when all land-marks have been destroyed, and then should be taken in order of priority of title, from the nearest established point.

Disputed line cases are generally tried before a jury. Any one who has gone through with such a case, knows that from the liability of the evidence to "tangle," the peculiar piece-meal form in which all evidence must be given in court, and the facility with which a smart lawyer can mix it, the jury, at the close, are infinitely less acquainted with the real facts of the case than they were at the beginning.

The judge, in charging, gives general points of law but leaves the *facts* to the jury. The result may generally be obtained from a copper.

It would save much time and weariness to all concerned, and promote justice, were these cases left to arbitration.

The use of the needle is the primary cause of much of the trouble in cases of disputed lines. If the points involved in question are carefully located by triangulation, the differences can be shown with an accuracy far beyond that obtained by magnetic bearings.

When we take into consideration the irregular, the daily, the annual and the secular variations of the needle, together with its liability to be affected by attractions that are imperceptible, it will be readily seen that the work based upon it must be only relatively correct.

When much of our state was a trackless forest, the needle was the only guide of the surveyor, as it is to-day that of the mariner upon the ocean; but the time of its usefulness in this direction has passed, and it would save many errors and disputes if the use of magnetic bearings were hereafter forbidden by law in the description of land, and the lines located from established points by interior angles and adjoinders.

TORPEDOES.

Nitro-glycerine [formula $C_6\ H_5\ (N\ O_4)_3\ O_6$], is prepared by dissolving glycerine in a mixture of equal measures of the strongest nitric and sulphuric acids, previously cooled, and pouring the solution in a thin stream into a large volume of water, when the Nitro-glycerine is precipitated as a colorless, heavy oil (Spec. Grav. 1.6).

It is advisable to add the glycerine to the mixed acids in very small quantities at a time, and to cool the mixture in a vessel of water after each addition.

When the Nitro-glycerine has subsided, the water may be poured off, and the oil shaken several times with water, so as to wash it thoroughly.

The formation of Nitro-glycerine resembles that of Gun-cotton, three equivalents of Hydrogen being removed from the Glycerine by the oxidizing action of the nitric acid, and three equivalents of nitric per-oxide introduced in their place.

This oil is far more violent in its explosive effects than Gun-cotton, more nearly resembling the fulminates, although not so easily exploded.

A drop of Nitro-glycerine placed on an anvil and struck, explodes with a loud report, even though not free from water; and if a piece of paper moistened with a drop of it be struck, it is blown into small fragments.

On the application of a flame, or of red-hot iron, Nitro-glycerine burns quietly, and when heated over a lamp in the open air, it explodes but feebly. In a closed vessel, however, it explodes at about 360° Fahr. with great violence.

The blasting effect of Nitro-glycerine is about ten times that of Gunpowder.

When it is kept, especially if it is not thoroughly washed, it decomposes, with evolution of nitrous fumes and formation of crystals of oxalic acid.

Should the gasses accumulate in such force as to burst the case, it would explode with great violence the entire contents.

It is soluble in Ether and Wood-spirit, and somewhat less so in Alcohol.

It congeals at 40° Fahr.

FULMINATE OF MERCURY.

FORMULA—C_4 $Hg._2$ N_2 O_4.

Fulminate of Mercury is prepared by dissolving one part of the Mercury in 12 of Nitric Acid. Spec. grav., .87.

When the chemical action has subsided, the vessel may be filled with water and the fulminate allowed to settle. It must be kept, when dry, in corked bottles, lest it be exploded between the neck and stopper.

It is used for the filling of percussion caps; explodes by heating to 300°, by the electric spark, and by contact with concentrated Nitric or Sulphuric Acid.

Fulminate of Silver is prepared in a similar way but its explosive properties are far more violent.

Formula—$Ag._2$ C_4 N_2 O_4.

Fulminating Powder—100 parts consist of

Mercury 70.4	} —76	
Oxygen 5.6		
Fulminic Acid	24	
	100	

REFINING.

Improvements in the process and machinery of refining have been so rapid that it would be far from advisable to describe any apparatus or mode of proceeding as a settled or permanent practice.

The amount of refined produced from crude oil will average, as a general rule, in practice, about 70 per cent. for oil of 46° to 48° gravity.

A greater per centage than this involves the loss of fire-test from the presence of the lighter oils, or of bad color from the presence of uncombined carbon.

While it is generally known, it may be worth while explaining here, that in the process of heating the crude oil, there are thrown over through the vapor pipes many different and separate oils.

At the beginning, we will say, comes over an oil represented by C^2 H^z, afterwards an oil represented by C^4 H^4, and so on, increasing in density until the oil passing over will be, perhaps, C^{60} H^{60}.

At the same time that these oils are passing over, other oils are passing, represented perhaps by C^2 H^4, C^4 H^6, C^{60} H^{62}, &c.

The light oils, above 61° gravity, are thrown into the benzine tank.

When the oil that is passing reaches 60° gravity, its direction is changed and it is thrown into the distillate tank, there to be treated with acid and properly cleaned.

This operation is called "cutting off." The time of "cutting off" will depend upon the gravity of the crude oil.

Stills are generally cut off from 59° to 64° of gravity.

The point, however, to be generally understood, is that the oil which we burn is not a single oil, but a combination of light and heavy oils, the exact proportion of which science has not yet determined.

In any fire test therefore, the vapors of the light oils will be thrown off and will flash, long before the body of the oil has been heated sufficiently to burn.

The adulteration of oil can seldom, if ever, be traced to the refiners, as it is not a matter of interest with them to do so.

It can be plainly seen, however, that it is a very simple thing to adulterate the best oil with oil of a lighter gravity, and, as a consequence, the oil that is retailed among the small dealers is very often under fire test.

The fire test now in use, if used with judgment and a knowledge of the facts above stated, is perhaps the best that can be found.

It has been proposed to use a graduated tube, open at one end, filled with oil and then inverted (after closing the other end) into water heated to a temperature of 110°; the gasses forming will collect in the upper end of the tube and will indicate upon the graduations, by their quantity, the test of the oil.

That this test would not be a just one is evident from the fact that an oil that will stand a fire test of 112° may, at a lower temperature, throw off light flashing vapors, in themselves harmless; and that an oil that would burn at 90° would, at even 110°, be comparatively free from vapors, the several oils composing it being more evenly combined.

The Hydrometer of Baumé, in use for indicating gravity, is calculated for a temperature of 60° Fahr.

When the oil is above or below this temperature at the moment of the test, an allowance in the result indicated, of one degree of gravity for every ten degrees of gravity above or below 60°, has been usually made.

It has been extended by Mr. Ohlen, and graduated by actual test for various temperatures, and in this form is of course more desirable and complete.

The following table shows Baumé's gravity at 60° Fahr. in comparison with the real specific gravity and the weight per cubic foot:

Formula: $g=\frac{146}{136+d}$

Baumé.	Real Gravity.	Wgt. in Lbs. per Cub. Ft.
10°	1000	62.379
15°	966.8	60.42
20°	942.3	58.87
25°	906.8	56.62
30°	879.5	54.9
35°	853.7	53.31
40°	829.	51.80
41°	824.8	51.50
42°	820.2	51.25
43°	815.5	50.93
44°	811.1	50.68
45°	806.6	50.37
46°	802.1	50.12
47°	797.2	49.82
48°	793.3	49.57
49°	789.1	49.31
50°	783.9	49.
60°	744.8	46.56
70°	708.7	44.31

From this table, properly extended, the gravity of the oil might be deduced from its weight; taking the expansion of oil to be equal to that of water, which is .00023325 for every degree of heat.

Then if X=weight per cubic foot at 60°,
y=actual weight per cubic foot,
y=x+or−(X×.00023325),
as the temperature is above or below 60°.

An ordinary hydrometer calculated for 60°, together with a carefully prepared table of gravities and weights per cubic foot for all temperatures, would enable oil to be sold with perfect accuracy by weight alone.

The inspection of oil, and the determining of the color, is something which requires an eye educated and accustomed to the work. Much of the oil that is off color comes from the want of attention to the cleaning of tank bottoms at proper intervals.

The improvements in the process of refining have for their primary object at present, the reduction of the cost of the operation.

The incentive to this will be readily apparent, when it is understood that the amount of refining capacity in the large cities and on the creek is considered to be three times that warranted by the daily production.

In the accomplishment of this object large stills have been constructed, so that more oil could be run with less labor.

These large stills have been arranged with outer fires under the edges of the still, having a strong draught towards the centre leading into a high stack, and thus saving much in the way of fuel.

In condensing and treating, also, a very strong, and probably successful, effort is being made, not only to do away with the old condenser with its vast coils of pipes, by substituting the use of steam in the vapor pipes, but also to treat the vapor at the same time with acid, and thus avoid another stage of the process.

SULPHURIC ACID,

When pure, is a heavy, oily, inodorous liquid, having a specific gravity of 1.842. It is intensely caustic, and chars almost all organic substances by subtracting water from them.

Its affinity for water is very great, doubling its weight by the absorption of vapor from the air, if left exposed in any open vessel for several days.

It freezes at 29° Fahr. and boils at 590° Fahr.

The Sulphuric Acid of commerce is never pure, but contains Lead from the leaden chambers in which it is made, Arsenic and Nitric Acid.

COMPARATIVE COMPOSITION OF PETROLEUMS & COAL OIL.

BURMAH OR RANGOON PETROLEUM.

Specific gravity .870—giving a gravity of Baumé of about 29°, and weight per cubic foot of 54 lbs.

Contains in distillation—

Of Tar, - - - - -	80 per cent.
Of Crude Oil having Spec. Gravity of .850 to .900, - - -	20 per cent.

PENNSYLVANIA PETROLEUM.

An average condensed vapor consists of Carbon, 85.05. Hydrogen, 14.30.

COAL OIL,

when distilled, consists of Carbon 83.04, Hydrogen 12.31 and Oxygen 4.65.

Both the above are liable to considerable variation from the quality of the crude material used, but are sufficiently correct for ordinary calculation.

In the distillation of the two following coals these results were obtained :

	Crude Oil.	Ammoniacal Water.	Coke.	Gas. Cub. Ins.
Breckenridge Cannel,	318.20.	52.10	455	445
Youghiogheny Coal,	136.	52.	710	545

HANDLING AND SHIPPING.

After the oil is produced at the well, an important question is that of placing it at the nearest shipping station with the least expense.

While this has long been successfully accomplished by means of pipe-lines, many most important principles and rules of hydraulics have been disregarded, and consequently the amount of work accomplished by the outlay of expense, is much below that which could be performed at the same cost.

The ordinary well tubing, being a common and merchantable article, has been adopted as the best conductor, and the pumps used, until recently, have been those built for the ordinary use of a manufactory or other work calling only for a short range.

The great length of these lines, however, not only changes the entire nature of the calculations usually made, but presents a branch of hydraulics without any parallel case which can be used as a basis.

If the oil were simply to flow through the pipes by its own gravity, or under the head of pressure from a tank or reservoir, as in the case of a water supply, the ordinary calculations used for water-pipes would answer.

But as this method would be far too slow, and as the oil is forced through the pipes with a pressure at the pumps of from 500 to 800 lbs. per square inch, the matter of *head* is completely overshadowed and absorbed by that of *friction* as the future demonstrations will show.

In the construction of a line it is desirable to know—

1st. The location presenting the best grade.

2nd. The highest point to be overcome.

3rd. The contents of the line.

4th. The pressure on the pump required to deliver a certain amount at the terminus.

5th. The pressure at various points along the line so as to arrange and distribute the tubing.

6th. The size of the Steam and Oil Cylinders best adapted to do the work of the line.

7th. The amount of boiler room for the Pump.

In locating the line it is hardly necessary to observe that the nearer it approaches a perfectly straight line, both vertically and horizontally, the better it will be.

It is generally possible to secure a direct course, following, however, the profile of the hills and streams over which it passes.

It is good practice, if you have an elevation to overcome, to take it at once and get to its highest point in as short a distance from the pump as possible. Any attempt to reach it by a circuitous route will only increase the friction and the consequent labor of the pump.

The method of calculating the capacity and pressures of a line, can be better understood by the following example of a line, eleven miles in length, recently laid.

The total length of the line, from pumping station to the point of delivery, was 60,363 feet.

Greatest elevation to be overcome, 403.82 feet.

Distance of greatest elevation from pump, 8663 feet.

The pumping station was $98\frac{31}{100}$ feet higher than the the ground at the point of delivery.

Estimated height of tanks and platforms to be deducted, say 20 feet, leaving 78.31 feet working difference of level.

For contents of line

d=diameter of pipe in inches.

l=length of pipe in feet.

Formula: $\frac{d^2}{30} \times l$=contents in gallons.

Applied:

$$\frac{4}{30} \times 60363 = 8048.4 \text{ gals.} = 187.1 \text{ bbls.}$$

CAPACITY OF LINE AND VELOCITY OF FLOW.

It was desired to deliver at the terminus 45 barrels per hour, of 43 gallons each, or $32\frac{25}{100}$ gallons per minute.

Then if v = velocity of flow in feet per minute.
c = contents of line.
b = barrels per hour required.
l = length of line in feet.

$$\frac{b \times l}{60 \times c} = v$$

Applied:

$$\frac{45 \times 60363}{60 \times 187\frac{1}{10}} = 242 \text{ ft. per minute, or 4 ft. per second.}$$

AMOUNT OF HEAT REQUIRED TO OVERCOME THE FRICTION OF THE LINE.

1st Formula: (Box) $H = \frac{G^2 \times L}{(3d)^5}$ (calculated for water.)

H = head required in feet.
G = gallons per minute to be delivered.
L = length of line in yards.
d = diameter of pipe in inches.

Applied:

$$\frac{1040 \times 20121}{7776} = 2691.1 \text{ feet.}$$

2nd Formula, (Weisbach), (calculated for water),

$$(.0144 \times \frac{.01746}{\sqrt{v}}) \times \frac{l}{d} \times \frac{v^2}{5.4} = h'$$

h′ = head required in feet.
v = velocity in feet per second.
l = length of line in feet.
d = diameter of pipe in inches.

Applied:

$$(.0144 \times \frac{.01746}{\sqrt{4}}) \times \frac{60363}{2} \times \frac{16}{5.4} = 2069.4 \text{ ft.}$$

The variation of these results, being the extremes of the standard authorities on these points, is doubtless caused by the problem of a pipe of such small diameter, worked under such great velocity, being an unusual case, not heretofore occurring in the practice of hydraulics.

The formula of Weisbach, although not as simple as that of Box, is undoubtedly the most accurate, from the fact that the element of velocity forms one of its quantities.

Its results also correspond with the observations of actual practice.

We have, therefore, as an index of power required to deliver 45 barrels per hour at the terminus,

Actual elevation to overcome, -	403.82 feet.
Head to overcome friction, - -	2069.4
Total head required, - -	2473.22

Amount of pressure per square inch for this head would be, in water, 1070.05 lbs.=to 2189.41 inches of mercury.

Taking the specific gravity of an average petroleum at .878, it would give us a pressure on the pump, for an unobstructed line, of 939.46 lbs. per square inch.

In the construction of a pump, the diameter of the oil cylinder should be maintained uniformly at but 50 to 100 per cent. increase over the size of the pipe. Should additional power be required, either on account of greater length of line, or of quantity to be delivered, the steam cylinder and length of stroke should be correspondingly enlarged; the motion it is well to confine to from 60 to 80 revolutions per minute.

A pump with a three inch oil cylinder, 14 inch stroke, and making 80 revolutions per minute, would deliver 34 gallons per minute.

To ascertain the amount of horse-power required, we find that the work to be done in the line above cited, is equal, when reduced, to 116,100,000 gallons raised one foot high in twenty-four hours, or a horse-power of $24\frac{36}{100}$ for water and $21\frac{39}{100}$ for oil, which would require for its exertion a steam cylinder of not less than 12 inches in diameter.

It is well to bear in mind that the capacity of the pump will be the capacity of the line for the amount to be delivered, outside of the strength of the pipe.

There are a number of minor points in the general arrangement for which it would be well to provide.

A pressure gauge upon the pipe at the pump, will indicate at once any leak or break in the line, and enable

the engineer to shut off at once before much damage is done ; it will also show, by increase, any choking or stoppage which would have a tendency to burst the line if the pumping did not cease at once.

The air chamber of the pump should be proportioned to the demands of the line and its capacity in contents. The increase of an air chamber by the addition of vertical tubing is but a slight remedy, as much depends upon the bell-shape.

The force used in propelling the oil comes directly from the air chamber, and it should therefore contain a sufficient amount of air to present a strongly elastic surface to the fluid pressing upon it ; and this elasticity, to be uniform, can only be obtained from the bell-shaped chamber.

To secure, at the pumping station, the full equivalent for the work of the pump, it is not only absolutely essential that the line be made as direct as possible, but that it be kept open to its full extent of diameter, the whole distance. Where stop-cocks are used, they should be free way cocks having an opening in the plug the exact size of the pipe, presenting, when open, no edge to create friction.

Where the pipe enters the receiving tanks it should be thrown in by a long sweep, if not direct, and not by elbows or sharp bends.

It must be borne in mind that a pound of resistance to be overcome at the terminus requires many pounds more labor at the pump.

For this reason it would be advisable theoretically to make a gradual increase in the diameter of the pipe from the pump to the terminus, although as these lines are often shifted in a few years, it perhaps would not be pecuniarily advantageous.

This problem of hydraulic transit is one which is not only novel and interesting, but one which will be regarded with more attention hereafter.

It may be well to note that the weakness and the strength of the points given above, lie in their variance with each special application, while, however, the principles involved remain unaltered.

No two lines in different localities and grades could ever be laid precisely similar and produce equal results.

MISCELLANEOUS.

EXCAVATING AND EMBANKMENTS.—It is better to form the outside of an embankment first and to gradually fill in the centre in order that the earth may arrange itself in layers with a dip from the sides inward; this will, in a great measure, counteract any tendency to slip outward.

A good laborer can throw out 526 cubic feet of earth in ten hours work.

In transporting earth in a wheelbarrow, the most economical method of conducting it, consists in so arranging the distance (termed a relay) for the first wheelbarrow to go over, that a man can go and return in the time it takes to load an empty barrow.

The relay on horizontal ground has been fixed at 120 feet, and similar experiments have shown that on sloping ground (the inclination of which should not exceed one perpendicular to twelve base) in order that the effort of a man in ascending may not be too great, the relay should be two-thirds of that on horizontal ground.

Ordinary earth, when perfectly dry and pulverulent, takes a natural slope of 43° 10′.

The natural slope of the same, slightly moistened and in its natural state, is 54°.

The natural slope of fine dry sand varies between 30° and 40°.

ROPES.—The fibres of hemp which compose a rope seldom exceed in length an average of 3½ feet.

Large ropes are divided into two main classes, the Cable-laid and the Hawser-laid: the former are composed of nine strands, namely: three great strands, each of these consisting of an equal number of secondary strands, which are individually formed with an equal number of primitive yarns.

A Cable-laid rope of 8 inches circumference is made up of 333 yarns or threads equally divided among the nine secondary strands.

A Hawser-laid rope consists of only three strands each composed of a number of primitive yarns proportioned to the size of the rope. For example, if it be 8 inches in circumference, it may have 414 equally divided among three strands.

Thirty fathoms of yarn are reckoned equal in length to eighteen fathoms of rope cable-laid, and to twenty hawser-laid. Ropes from 1 to 2½ inches in circumference are usually hawser-laid, from 3 to 10 inches either hawser or cable-laid, and over 10 inches always cable-laid.

To estimate the strength of ropes, square the circumference of the rope in inches and take one-fifth of the amount for the weight in tons which it will bear.

Tarred ropes have 25 per cent. less strength than white ropes in consequence of the injury the fibres receive from the high temperature of the tar, 290°

Manilla ropes have from 25 to 30 per cent. less strength than white ropes.

TO COMPUTE THE WEIGHT OF ROPES, HAWSERS AND CABLES.

Rule. Square the circumference and multiply it by the appropriate unit in the following table, and the product will give the weight per foot in pounds.

3 Strand Hemp, - -	.031	4 Strand Hemp, - -	.033
3 Strand Tarred Hemp,	.041	4 Strand Tarred Hemp,	.048
3 Strand Manilla, - -	.032	4 Strand Manilla, - -	.035

Timber.—Oak, for the greatest strength and durability, should be chosen from those soils where it has taken the longest time to grow to maturity, and of two equally dry pieces of any timber in general, that is the best which has the greatest specific gravity, or that which will have its specific gravity least changed by being soaked in water.

A decay of the top is almost a certain indication of the decay of a tree.

In a similar soil, trees which grow near the outside of a forest will be more durable than those in the middle of it, and in the same tree, the side which grew toward the north will be stronger than the south side.

Timber used in damp situations begins to decay at the outer ring first (where a whole tree is used) and goes on toward the innermost ring.

When a tree is past its prime before it is cut down, it begins to decay at the innermost ring and goes outward.

WEIGHT OF A CUBIC FOOT OF VARIOUS SUBSTANCES.

Sand (solid),	112.5 lbs.
" (loose),	95. "
Clay,	120 to 135. "
Brick,	119. "
One cubic yard of sand weighs,	3037. "
" " " " common soil,	3429. "

Lime and sand, likewise cement and sand, lose one-third of their bulk when made into mortar.

TO ESTIMATE THE NUMBER OF BRICKS IN A STRUCTURE, WHEN LAID.

Allow 14 bricks in length for every ten feet.
" 9 " height for every two feet.
or 22 bricks to the cubic foot.

13	cubic	feet	of	earth	weigh	one ton.
17	"	"	"	clay	"	" "
21¾	"	"	"	gravel	"	" "
23½	"	"	"	sand	"	" "
39	"	"	"	oak	"	" "
1	cubic	foot	of	cast iron	weighs	450 lbs.
1	"	"	"	wrought iron,		475 "
1	"	"	"	closely ham'ered,		485 "

TO BORE A HOLE THROUGH GLASS.

Pour turpentine around the point of the drill while using.

A body falling one foot strikes with eight times its own weight.

STEEL may be distinguished from pure iron by its giving a dark gray spot when a drop of diluted nitric acid is let fall on its surface, while iron affords a green one.

Exposed to the air, steel rusts less rapidly than iron, and the more highly carburetted, the more slowly does it rust and the blacker is the spot left by the acid.

MASON'S MASTIC FOR COATING THE INSIDE OF CISTERNS, BASINS, ETC.

Pulverized Bricks, - - - - -	2 Parts.
Quicklime, - - - - - -	2 "
Wood Ashes, - - - - - -	2 "
Sweet Oil, - - - - - -	4 "

CONTRACTION OF IRON.—$\frac{1}{151200}$ of its length for each degree of head subtracted.

TABLE OF TEMPERATURES, "POUILLET."

Incipient redness, - -	525°	Dark yellow-red, - -	1100°
Dull redness, - - -	700°	Bright ignition, - -	1200°
Cherry red commencing,	800°	White heat, - - -	1300°
" brighter, -	900°	Strong white heat, -	1400°
" full, - -	1000°	Dazzling white heat,	1600°

The curvature of the earth is about 8 inches to the mile.

WRIGLEY & GRAY,

Civil Engineers, Architects

AND

SOLICITORS OF PATENTS.

Office Building, on Pine Street, beyond Abbott House,

TITUSVILLE, PENN.

Business established in 1864.

Refer to their past large practice as Land Surveyors in all parts of the Oil Region. Their Lease and Corner Stakes, of dry chesnut, painted and numbered, preserve the work done in a permanent manner, and are well known. Particular attention given to the Settling of Disputed Lines and the Locating of Old Lines, now extinct.

Their experience, also, in the Location and Construction of Pipe Lines enables them to guarantee a Line of good capacity, with the lightest working expense.

Refer, also, to the following Buildings, erected by them throughout the Region:

St. John's Episcopal Church, Rouseville.
Ascension Chapel, Titusville.
Citizens' Bank, Titusville.
Residence of W. H. Abbott, Esq.
Residence of A. H. Bronson, Esq.
Residence of H. P. Smith, Esq.
Residence of P. W. Garfield, Esq.
Residence of W. C. Chapin, Esq.
Store of Jno. R. Bevans.
Beers' Block, Oil City.
Episcopal Parsonage, Titusville.

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For the accommodation of patrons, a Patent Agency was established a few years since, in connection with JAS. L. NORRIS, ESQ., of Washington, D. C., enabling Inventors to perfect their drawings and papers under their own supervision, and at the same time have the case properly attended to when it reaches the Patent Office.

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Promptly attended to in all parts of the Oil Regions, and executed in the best manner.

CHEAP WORK,

Being unprofitable to the employer and discreditable to the employed *is not wanted under any circumstances.*

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Architect and Civil Engineer.

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COMMENCED DRILLING .....

COMMENCED PUMPING .....

PRODUCTION.

	Bbls.	Daily Average.	Price Average.	Total Rec'pts for Month.	Expenses for Month.	Profit.

..... WELL.

..... FARM.

RECORD. FEET.

MONTH.

Whole Depth,

Length of Driving Pipe,

First Sand at

Thickness,

Second Sand at

Thickness,

Third Sand at

Thickness,

Fourth Sand at

Thickness,

Fifth Sand at

Thickness,

COST.

RIG.

—MOVABLES.—

Engine and Boiler,

Rope, Tools, &c.,

Casing, ft. @ c.

Tubing, ft. @ c.

Wear and Tear,

Drilling and Driving Pipe,

COMMENCED DRILLING .....

COMMENCED PUMPING .....

PRODUCTION.

	Bbls.	Daily Average.	Price Average.	Total Rec'pts for Month.	Expenses for Month.	Profit.

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Whole Depth,

Length of Driving Pipe,

First Sand at

Thickness,

Second Sand at

Thickness,

Third Sand at

Thickness,

Fourth Sand at

Thickness,

Fifth Sand at

Thickness,

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Engine and Boiler,

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RECORD.	FEET.	MONTH.
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Length of Driving Pipe,		
First Sand at		
Thickness,		
Second Sand at		
Thickness,		
Third Sand at		
Thickness,		
Fourth Sand at		
Thickness.		
Fifth Sand at		
Thickness,		

COST.		
RIG.		
MOVABLES. Engine and Boiler,		
Rope, Tools, &c.,		
Casing, ft. @ c.		
Tubing, ft. @ c.		
Wear and Tear,		
Drilling and Driving Pipe,		

COMMENCED DRILLING .....

COMMENCED PUMPING .....

PRODUCTION.

Bbls.	Daily Average.	Price Average.	Total Rec'pts for Month.	Expenses for Month.	Profit.

WELL.

FARM.

RECORD. FEET.

MONTH.

Whole Depth,

Length of Driving Pipe,

First Sand at

Thickness,

Second Sand at

Thickness,

Third Sand at

Thickness,

Fourth Sand at

Thickness,

Fifth Sand at

Thickness,

COST.

RIG.

—MOVABLES.—

Engine and Boiler,

Rope, Tools, &c.,

Casing, ft. @ c.

Tubing, ft. @ c.

Wear and Tear,

Drilling and Driving Pipe,

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